Division 10

NATIONAL BUREAU OF STANDARDS REPORT

6626

PERFORMANCE TESTS OF A REPLACEABLE CARTRIDGE AIR FILTER
CAMBRIDGE "AEROSOLVE" 3A-85

Manufactured by
Cambridge Filter Manufacturing Corporation
Syracuse, New York

by

Carl W. Coblentz
and
Paul R. Achenbach

Report to

Public Buildings Service
General Services Administration
Washington 25, D. C.

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

THE NATIONAL BUREAU OF STANDARDS

Functions and Activities

The functions of the National Bureau of Standards are set forth in the Act of Congress, March 3, 1901, as amended by Congress in Public Law 619, 1950. These include the development and maintenance of the national standards of measurement and the provision of means and methods for making measurements consistent with these standards: the determination of physical constants and properties of materials; the development of methods and instruments for testing materials, devices, and structures; advisory services to government agencies on scientific and technical problems; invention and development of devices to serve special needs of the Government; and the development of standard practices, codes, and specifications. The work includes basic and applied research, development, engineering, instrumentation, testing, evaluation, calibration services, and various consultation and information services. Research projects are also performed for other government agencies when the work relates to and supplements the basic program of the Bureau or when the Bureau's unique competence is required. The scope of activities is suggested by the listing of divisions and sections on the inside of the back cover.

Publications

The results of the Bureau's work take the form of either actual equipment and devices or published papers. These papers appear either in the Bureau's own series of publications or in the journals of professional and scientific societies. The Bureau itself publishes three periodicals available from the Government Printing Office: The Journal of Research, published in four separate sections, presents complete scientific and technical papers; the Technical News Bulletin presents summary and preliminary reports on work in progress; and Basic Radio Propagation Predictions provides data for determining the best frequencies to use for radio communications throughout the world. There are also five series of nonperiodical publications: Monographs, Applied Mathematics Series, Handbooks, Miscellaneous Publications, and Technical Notes.

Information on the Bureau's publications can be found in NBS Circular 460, Publications of the National Bureau of Standards ($1.25) and its Supplement ($1.50), available from the Superintendent of Documents, Government Printing Office, Washington 25, D.C.

NATIONAL BUREAU OF STANDARDS REPORT

NBS PROJECT		NBS REPORT
1003-30-10630	January 8, 1960	6626

PERFORMANCE TESTS OF A REPLACEABLE CARTRIDGE AIR FILTER
CAMBRIDGE "AEROSOLVE" 3A-85

Manufactured by
Cambridge Filter Manufacturing Corporation
Syracuse, New York

by

Carl W. Coblentz and Paul R. Achenbach
Air Conditioning, Heating, and Refrigeration Section
Building Technology Division

to

Public Buildings Service
General Services Administration
Washington 25, D. C.

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

Performance Test of a Replaceable Cartridge Air Filter
Cambridge "Aerosolve," Model 3A-85

by

Carl W. Coblentz and Paul R. Achenbach

1. INTRODUCTION

At the request of the Public Buildings Service, General Services Administration, the performance characteristics of a Model 3A-85 Cambridge "Aerosolve" replaceable cartridge air filter were determined. The scope of this examination included the dust holding capacity of the filter, and separate determinations of the arrestance of Cottrell precipitate and the particulate matter in the laboratory air.

2. DESCRIPTION OF TEST SPECIMEN

The test specimen was manufactured and supplied for test purposes by the Cambridge Filter Manufacturing Corporation of Syracuse, New York, and was identified as their Model 3A-85 "Aerosolve" replacement cartridge. The size of the filter was 23 1/2" x 23 1/2" x 12". The filter medium was a fiber glass blanket, about 3/16" thick, which was glued to a supporting thin layer of glass fibers, on the downstream side. It was arranged in twelve pleats, each 12 in. deep, and presented an effective filtering surface of approximately 40 sq ft. The sides of the filter medium were glued to a corrugated cardboard frame. The weight of the clean filter was 2480 grams (5 1/2 lbs).

The manufacturer also furnished a welded steel frame into which the filter was to be placed during operation. When the cartridge was inserted into this frame from the front side, each pleat was supported for its full length on a grid of steel wires that fitted into the pleated media to control deflection and prevent rupture of the media. The pressure against the filter cartridge that was produced by the air flow pressed the pleats of the filter medium against the steel wire grid and the downstream face of the cardboard frame was pressed against a felt gasket installed in the steel frame to prevent air leakage around the filter.

3. TEST METHOD AND PROCEDURE

Arrestance determinations were made by the NBS "Dust Spot Method" using the following aerosols: a) the particulate matter in the laboratory air and b) Cottrell precipitate. The test method is described in the paper entitled, "A Test Method for Air Filters," by R. S. Dill (ASHVE Transactions, Vol. 44, p. 379, 1938).

The sampling air was drawn from the center points of the test duct one foot upstream and eight feet downstream of the filter under test at equal flow rates and passed through known areas of Whatman No. 41 filter paper. The change of opacity of these areas was determined with a sensitive photometer which measured the light transmission of the same area on each sampling paper before and after the test. The two sampling papers used for each test were selected to have the same light transmission readings when clean.

For determining the arrestance of the filter with Cottrell precipitate as the aerosol, different sized areas of sampling paper were used upstream and downstream of the filter to collect the dust in order to obtain a similar increase of opacity on both sampling papers. The arrestance, A (in percent) was then calculated by the formula:

$$A = \left(1 - \frac{S_D}{S_U} \times \frac{\Delta D}{\Delta U} \right) \times 100$$

where S_D and S_U are the downstream and upstream areas and ΔD and ΔU the observed changes in the opacity of the downstream and upstream sampling papers, respectively.

A slightly different sampling procedure was used for determining the arrestance of the particulate matter in the laboratory air. In this case, a similar increase of opacity on the two sampling papers was obtained by using equal areas for the downstream and upstream sampling papers and passing air through the upstream paper only part of the time while operating the downstream paper continuously. This was accomplished by installing a solenoid valve and a parallel bypass valve in the air line of the upstream sampler and using an electric timer to open the solenoid valve and close the bypass valve any desired percentage of a 5-minute cycle. The timer reversed the positions of the solenoid and bypass valves for the remainder of each 5-minute sampling cycle.

The arrestance, A (in percent) was then determined with the following formula:

$$A = 100 - T \times \frac{\Delta D}{\Delta U}$$

where T is the percentage of time during which air was drawn through the upstream sampler, ΔD and ΔU being the changes in opacity of the sampling papers, as previously indicated.

The following procedure was employed in testing this filter: The filter cartridge was inserted into the holding frame and, instead of the usual clamps which would press the downstream face of the cardboard frame against the felt gasket, several strips of masking tape were used to hold the cartridge in place. This make-shift arrangement was used since the steel holding frame was specially made to fit the test apparatus and did not have the clamps provided in the stock models.

After determining the pressure drop of the clean specimen at air flow rates from 600 cfm to 1200 cfm, several determinations of the arrestance of the particulate matter in the laboratory air were made at the rated air flow rate of 1000 cfm. Thereafter, two arrestance determinations with Cottrell precipitate were made and then the loading of the filter with Cottrell precipitate and lint in a ratio of 96 to 4, by weight, commenced at a feed rate of approximately 1 gram of Cottrell precipitate per 1000 cu ft of air.

The Cottrell precipitate had been previously sifted through a 100-mesh standard wire screen and the lint was prepared from #7 cotton linters by running these through a Wiley mill with a 4 mm screen. Further arrestance determinations were made with Cottrell precipitate after the pressure drop across the filter nad reached 0.3 in. W.G. When the pressure drop had reached 0.5 in. W.G. and again after it reached 0.85 in. W.G., further arrestance determinations with both aerosols were made.

4. TEST RESULTS

The performance of the test specimen is summarized in Table 1 showing the dust load, the pressure drop and the arrestance of the dust particles in the laboratory air and Cottrell precipitate at the rated air flow rate of 1000 cfm. The dust load shown in this table is the weight of Cottrell precipitate and lint introduced into the test apparatus diminished by the percentage of dust

fallout upstream of the filter. This fallout was determined by sweeping out the test apparatus at the conclusion of the test. The amount of dust swept out of the upstream portion of the test duct was 47 g or 3.6% of the 1307 g of Cottrell precipitate and lint introduced during the test.

Table 1

Performance of a Model 3A-85 Cambridge "Aerosolve" Air Filter at 1000 cfm Air Flow Rate

Dust Load g	Pressure Drop in. W.G.	Arrestance %	Aerosol Used**
0	0.253	69.5*	A
19	0.259	97.1*	B
309	0.310	98.3*	B
580	0.359	----	
920	0.511	98.3*	B
940	0.520	77.4	A
1260	0.856	98.4*	B
1260	0.865	84.9	A

* Average of two or more tests

** A - Particulate matter in laboratory air
B - Cottrell precipitate in laboratory air (Rate of feed = 1 gram per 1000 cu ft)

The pressure drop of the clean specimen was 0.253 in. W.G. and increased to 0.865 in. W.G. after 1260 g of dust had reached the filter at the rated air flow rate. The arrestance of Cottrell precipitate increased from 97.1 percent when the filter was clean to 98.3 percent after 309 g of dust had reached the filter and then remained practically constant. The arrestance of the particulate matter in the laboratory air increased from 69.5 percent with a clean filter to 77.4 percent at a pressure drop of 0.520 in. W.G. and rose to 84.9 percent at the end of the test.

The values of Table 1 are shown graphically in Figure 1, where both the pressure drop and the arrestance values are plotted against the dust load as smooth curves which approximately fit the individual points of observation. The curve drawn for the arrestance of the dust in the laboratory air indicates the average value for the duration of the loading period was approximately 75 percent.

CAMBRIDGE MODEL 85

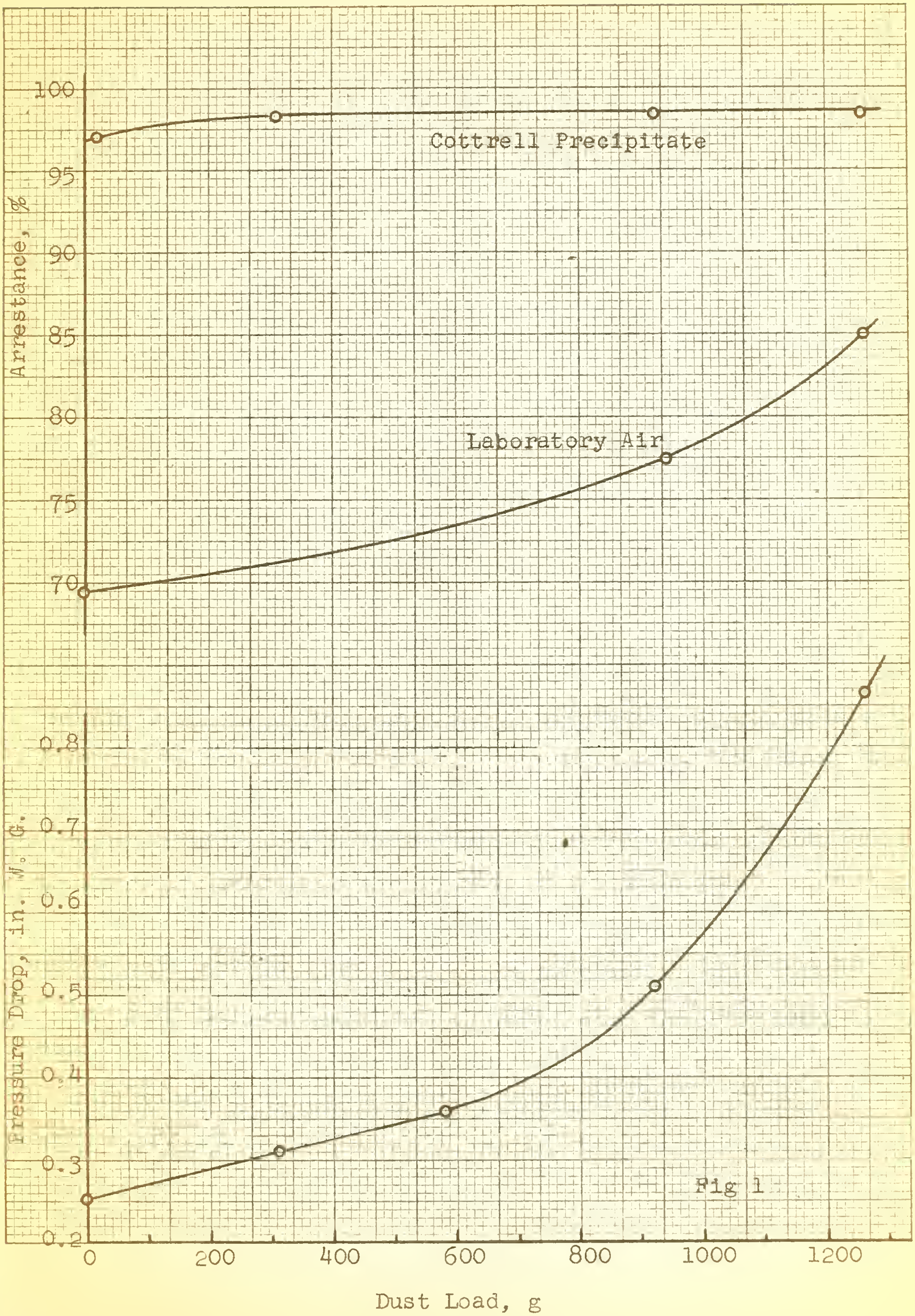

Fig 1

Table 2

Pressure Drop of Clean Filter at
Different Air Flow Rates

Air Flow Rate cfm	Pressure Drop in. W.G.
600	0.146
800	0.204
1000	0.253
1200	0.314

Table 2 above shows the pressure drop of the clean test specimen at air flow rates from 600 cfm to 1200 cfm. It will be noted that the pressure drop increased over this range from 0.146 in. W.G. to 0.314 in. W.G. approximately in direct proportion to the air flow rate.

U.S. DEPARTMENT OF COMMERCE
Frederick H. Mueller, *Secretary*

NATIONAL BUREAU OF STANDARDS
A. V. Astin, *Director*

THE NATIONAL BUREAU OF STANDARDS

The scope of activities of the National Bureau of Standards at its major laboratories in Washington, D.C., and Boulder, Colorado, is suggested in the following listing of the divisions and sections engaged in technical work. In general, each section carries out specialized research, development, and engineering in the field indicated by its title. A brief description of the activities, and of the resultant publications, appears on the inside of the front cover.

WASHINGTON, D.C.

Electricity and Electronics. Resistance and Reactance. Electron Devices. Electrical Instruments. Magnetic Measurements. Dielectrics. Engineering Electronics. Electronic Instrumentation. Electrochemistry.

Optics and Metrology. Photometry and Colorimetry. Photographic Technology. Length. Engineering Metrology.

Heat. Temperature Physics. Thermodynamics. Cryogenic Physics. Rheology. Molecular Kinetics. Free Radicals Research.

Atomic and Radiation Physics. Spectroscopy. Radiometry. Mass Spectrometry. Solid State Physics. Electron Physics. Atomic Physics. Neutron Physics. Radiation Theory. Radioactivity. X-rays. High Energy Radiation. Nucleonic Instrumentation. Radiological Equipment.

Chemistry. Organic Coatings. Surface Chemistry. Organic Chemistry. Analytical Chemistry. Inorganic Chemistry. Electrodeposition. Molecular Structure and Properties of Gases. Physical Chemistry. Thermochemistry. Spectrochemistry. Pure Substances.

Mechanics. Sound. Mechanical Instruments. Fluid Mechanics. Engineering Mechanics. Mass and Scale. Capacity, Density, and Fluid Meters. Combustion Controls.

Organic and Fibrous Materials. Rubber. Textiles. Paper. Leather. Testing and Specifications. Polymer Structure. Plastics. Dental Research.

Metallurgy. Thermal Metallurgy. Chemical Metallurgy. Mechanical Metallurgy. Corrosion. Metal Physics.

Mineral Products. Engineering Ceramics. Glass. Refractories. Enameled Metals. Constitution and Microstructure.

Building Technology. Structural Engineering. Fire Protection. Air Conditioning, Heating, and Refrigeration. Floor, Roof, and Wall Coverings. Codes and Safety Standards. Heat Transfer. Concreting Materials.

Applied Mathematics. Numerical Analysis. Computation. Statistical Engineering. Mathematical Physics.

Data Processing Systems. SEAC Engineering Group. Components and Techniques. Digital Circuitry. Digital Systems. Analog Systems. Application Engineering.

- Office of Basic Instrumentation.
- Office of Weights and Measures.

BOULDER, COLORADO

Cryogenic Engineering. Cryogenic Equipment. Cryogenic Processes. Properties of Materials. Gas Liquefaction.

Radio Propagation Physics. Upper Atmosphere Research. Ionospheric Research. Regular Propagation Services. Sun-Earth Relationships. VHF Research. Radio Warning Services. Airglow and Aurora. Radio Astronomy and Arctic Propagation.

Radio Propagation Engineering. Data Reduction Instrumentation. Modulation Research. Radio Noise. Tropospheric Measurements. Tropospheric Analysis. Propagation Obstacles Engineering. Radio-Meteorology. Lower Atmosphere Physics.

Radio Standards. High Frequency Electrical Standards. Radio Broadcast Service. High Frequency Impedance Standards. Electronic Calibration Center. Microwave Physics. Microwave Circuit Standards.

Radio Communication and Systems. Low Frequency and Very Low Frequency Research. High Frequency and Very High Frequency Research. Ultra High Frequency and Super High Frequency Research. Modulation Research. Antenna Research. Navigation Systems. Systems Analysis. Field Operations.

NBS